Unequal Error Protection of SNR-Scalable DPCM-Coded Video

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A channel code allocation scheme is developed for unequal error protection of video packets when transmitted over error-prone channels.

The allocation procedure minimizes the expected distortion of one Group of Pictures, made by loss of a particular channel packet, which terminates the GOP's decoding, and following error concealment. One source packet, generated by a quality-controlled block-based hybrid coding technique like in H.264, represents a rectangular region of so-called macroblocks at a particular SNR layer in a certain video frame. Based on a set of available channel codes, several or only parts of source packets are conveyed as payload data in channel packets of fixed length. The distortion of a certain channel packet accounts further for data dependence of its payload in terms of coefficient prediction (for SNR scalability purposes), temporal prediction, the terminate-on-error decoding strategy, and three different error concealment methods. The algorithm terminates when all bits from the non-embedded source bit stream are used up. The investigated channel model is a binary symmetric channel, where a packet loss is declared with at least one residual bit error after channel decoding. The channel codes used are punctured parallel concatenated recursive convolutional codes. The work features the Viterbi Algorithm as allocation procedure.

With a channel bit error rate in the range from 0 to 0.14, the joint source channel codec is capable of holding the average expected distortion of all GOPs of a sequence almost constant. Furthermore, the difference between the expected distortion in channel mismatch situations, where the true error rate is de-/increased by 10%, and the distortion without mismatch is less than 0.2 dB, i.e. the quality degrades gracefully. With a bit rate of 181 Kbits/s and at low error rates (< 0.005), the developed system achieves an image quality of roughly 35 dB for a YUV 4:2:0 QCIF video at 10 frames/s. At high error rates (> 0.12), a rate of 327 Kbits/s yields a quality of 34.7 dB. This corresponds to a decrease of the overall channel code rate from 0.59 to 0.33. Proper operation of the system is warranted up to an error rate of approximately 0.14, the expected distortion increases dramatically beyond that value. The distribution of channel codes shows that, while searching for the code allocation which gives minimum distortion, the codec aims at the maximization of the average payload length of channel packets. Packets, the loss of which would give high distortions, are protected by strong channel codes, whereas less important packets are assigned weaker codes.